DEMONSTRATING TRANSIT SCHEDULE BENEFITS WITH A DSRC-BASED CONNECTED VEHICLE SYSTEM

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Introduction

A vehicle-to-infrastructure (V2I), connected vehicle system was installed along Redwood Road in Salt Lake City, Utah, in November 2017 using dedicated short range communication (DSRC) radios to connect transit buses to traffic signals. The project goals included improving the schedule reliability of the bus from 86% to 94% by providing transit signal priority (TSP) at traffic signals when the bus is behind its published schedule by a certain threshold.

Data for the analysis was obtained from: 1) UTA transit operations system (SIRI), 2) DSRC communications, and 3) Automated Traffic Signal Performance Measures (ATSPM) system.

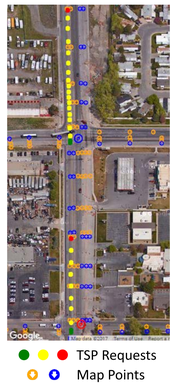
Data from these three systems allow for detailed analysis of priority requests made, requests served, and bus on-time performance in a way that is not possible without these data sets. The UTA Reliability Database was used to compare reliability of DSRC-equipped buses against non-equipped buses.

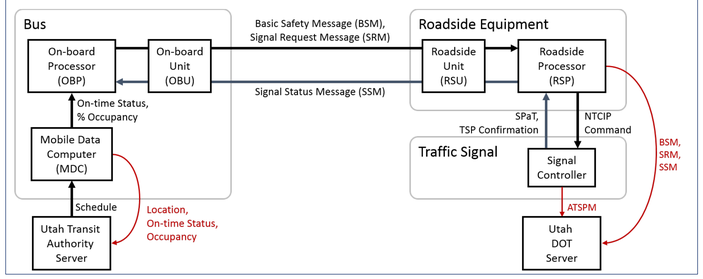
Measuring Performance

Use of high-resolution traffic data from the signal controller facilitates evaluation of traffic conditions using field data instead of simulations. Coupled with robust detection systems, this allowed us to perform detailed analysis of:

1) Vehicle arrivals
2) Signal operations
3) Split failures
4) TSP service

Data Source	Data
UTA SIRI Database	bus reliability, bus occupancy
DSRC Database	Bus location, TSP requests
ATSPM Database	SPaT, TSP service





On-going Efforts

- An evaluation of traffic at the intersections where transit priority is granted showed limited negative impacts on traffic operations.
- Reducing the lateness threshold and the resulting impact on bus reliability and frequency of TSP services.
- This TSP system is operating on a new bus-rapid transit system in Provo and Orem, Utah, with 47 intersections and 25 buses. A similar reliability analysis is planned for that corridor.
- The system will be used to provide signal preemption to snow plows that are actively plowing snow, initially at 55 intersections along four corridors in Salt Lake County. Plow cycle time and traffic speeds will be evaluated.

Deployment

Redwood Road in Salt Lake City, Utah
- State-owned north-south arterial
- 11 miles long (analysis confined to southern 6 miles)
- 30 signalized intersections (17 within study area)
- AADT: 40,000 to 60,000

DSRC-based Connected Vehicle System
- Lear DSRC RSUs at 13 of 17 intersections
- Lear DSRC OBUs on 4 UTA buses
- Software running on Linux processor

UTA buses running on 15-minute headway most of the day

Priority System Operations

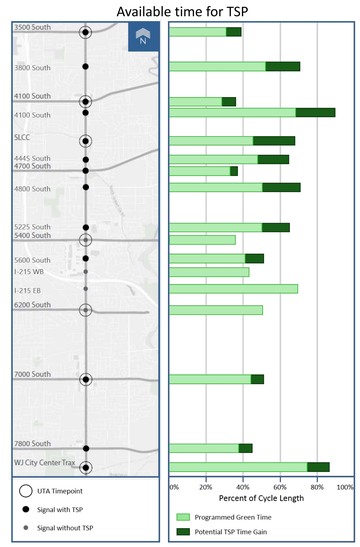
Equipped buses on the corridor were allowed to request TSP when:

1) The bus was behind published schedule by a given threshold (5 minutes)
2) The bus had at least 20% occupancy (9 passengers)

TSP application software is based on the Multi-Modal Intelligent Traffic Signal System (MMITSS).

TSP is facilitated by a series of messages passed between the traffic signal and the bus using DSRC in accordance with the SAE J2735-2016 standard.

System Operation Timeline:
- Operational mode: December 2017 (the first DSRC-based connected vehicle system in the U.S. to be fully operational in a functioning transportation system)
- Initial System Evaluation: February – March 2018
- System Analysis for this study: April –July 2018



Results

Optimal TSP operation requires a balance of the frequency of TSP service and the amount of additional green time allocated for TSP.
- Too many TSP services can negatively impact other road users.
- Too few TSP services might limit benefits to the transit system.

Study Results

RELIABILITY
- Buses with TSP experienced improved schedule adherence compared to those buses that do not have this capability.
- Weekday reliability across all time periods improved from 94 to 97 percent. The most significant advantage occurred during peak periods in the peak direction:

Average Reliability	Southbound PM Peak			Northbound AM Peak		
	No TSP	TSP	Benefit	No TSP	TSP	Benefit
Along Route	86%	91%	***+5%***	96%	98%	**+2%**
End of Route	89%	97%	***+8%***	85%	98%	**+13%**

TSP REQUESTS AND SERVICES
- These improvements were made with only 35 percent of the requests for TSP being served.
- The need for TSP service decreases as the available green time for the approaches increases, allowing for the buses to pass through the intersection with normal operations.

Sample size during the four-month study:

	AM Peak	PM Peak
Equipped buses	85	170
Un-equipped buses	829	1081